30 records as there are survey points along the leveling line. However, if a loop is closed (as in the case of a spur loop or if the line itself forms a closed loop), an additional *30* record must appear in proper sequence (see below) for the endpoint of each such loop, reflecting the elevation carried forward to that bench mark or temporary bench mark via the loop.

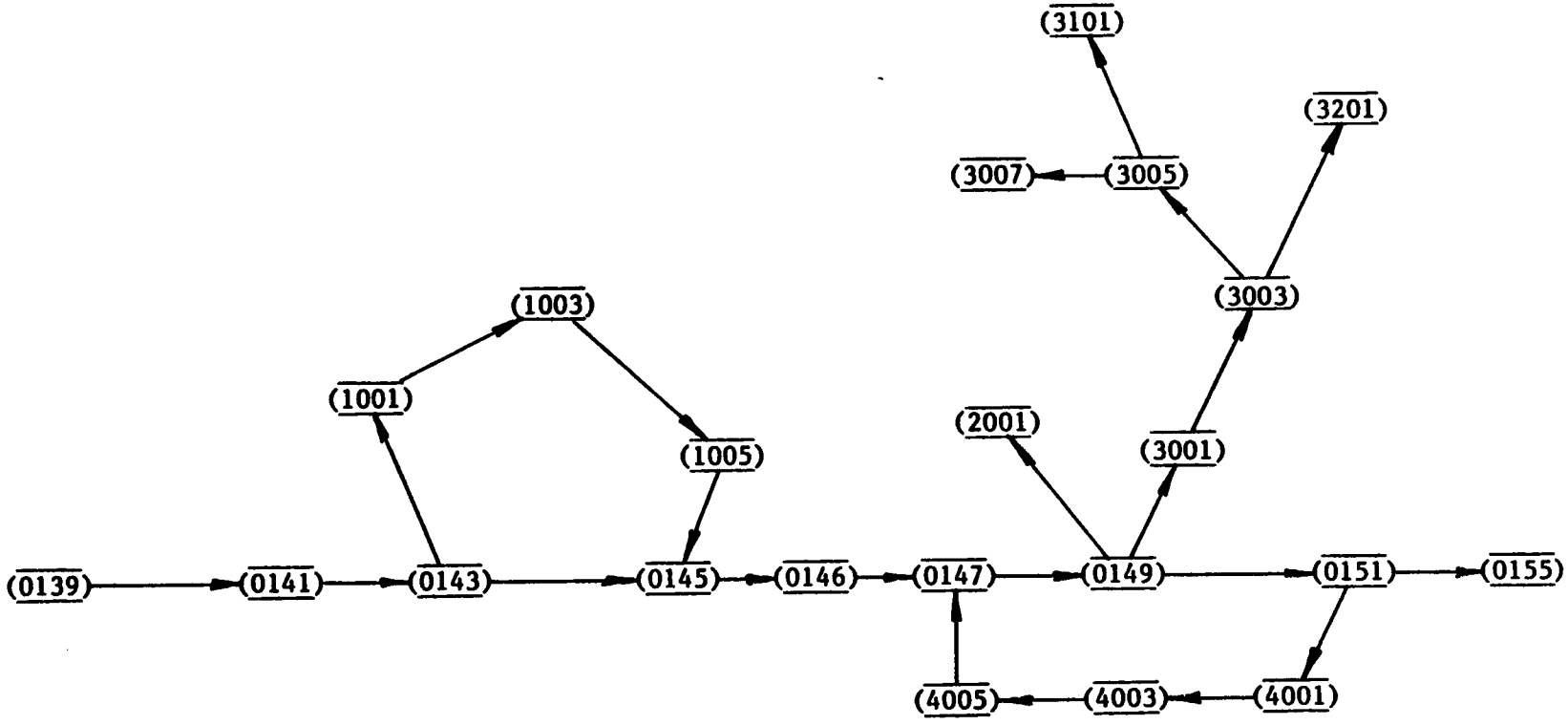
Order of the *30* Records: As was previously covered in the section on the STRUCTURE OF THE VERT OBS DATA SET, the order of the *30* records is crucial. This is because the *30* records, as a group, define the leveling line in question, i.e., they define the nominal sequence of bench marks and temporary bench marks along the leveling line.

Normally, the *30* records should follow the same sequence as the respective survey points occur along the leveling line. However, one or more spurs may emanate from any survey point - in which case, after the *30* record for such a "base" point, the *30* records for all survey points along the longest spur must follow first, then those along the next-longest spur, etc. Only when all spurs emanating from that base point have thus been exhausted should the *30* record for the elevation carried forward to the next survey point along the main route of the leveling line be given - see example in Figure 6-1.

Survey Point Serial Number: For the purpose of identifying the initial and terminal points of each section of the leveling line in a concise and unique manner (e.g., on the respective *41* and *42* records - see OBSERVATION DATA RECORDS), each survey point that is leveled to in a vertical control job (bench mark or temporary bench mark) is assigned a job-specific serial number in the range 0001 to 9999. All survey points for which recovery descriptions are written, but which were not leveled to in the current project, are to be assigned the SPSN code 0000. See Chapter 5 for a detailed explanation of the survey point numbering system.

The survey point serial number (SPSN) is also used in the correlation of the data pertaining to the bench marks and temporary bench marks which appear in the VERT OBS data set with the corresponding descriptive data contained in the companion VERT DESC data set of the vertical control job. For this reason, special care must be taken to insure that the identical survey point serial number assigned to a bench mark or temporary bench mark in the VERT OBS data set is also used to identify the same survey point in the respective companion VERT DESC data set.

Designation: A vertical control point or bench mark is normally identified by a numeric or alphanumeric symbol which is stamped on the disk marker (or is otherwise inscribed on the bench mark monument) to which is appended the abbreviation or acronym (see Annex C) of the agency whose name is precast in the monument - if other than the



Sequence of the *30* Records:

1. 0139	5. 1003	9. 0146	13. 3003	17. 3201	21. 4003
2. 0141	6. 1005	10. 0147	14. 3005	18. 2001	22. 4005
3. 0143	7. 0145	11. 0149	15. 3101	19. 0151	23. 0147
4. 1001	8. 0145	12. 3001	16. 3007	20. 4001	24. 0155

FIGURE 6-1 - Example of Field Abstract Record sequence.

National Geodetic Survey, National Ocean Survey, or Coast and Geodetic Survey (see Origin). For marks not having a precast agency name, append the acronym or abbreviation of the agency which set the mark (see Setting-by-Agency). If the agency cannot be determined, do not append an agency acronym or abbreviation. Less frequently, a bench mark is assigned a concise, intelligible name (e.g., when a horizontal control point also becomes a bench mark); the appropriate acronym or abbreviation should be appended to these also. A maximum of 25 characters (including all imbedded blanks) is allowed.

In every case, the bench mark designation entered on the *30* record must be identical to the (primary) designation used to identify the same vertical control point in the companion VERT DESC data set of the vertical control job - refer to Chapter 7. Use the same general guidelines for the designations of any survey points which lack descriptive data (e.g., undescribed temporary bench marks which may have to be carried in the VERT OBS data set but which do not appear in the companion VERT DESC data set).

Accumulated Distance: The distance covered by the differential leveling operation from the nominal starting point of the leveling line to the survey point in question. It is obtained by successively adding the lengths of the intervening sections (following the line-order conventions used for the ordering of the *30* records in the case of a survey point located on a spur or leveled to via a spur loop - see Order of the *30* Records). Recall that "section" is a segment of the leveling line consisting of two neighboring survey points connected by a chain of differential leveling observations (i.e., connected by a "running").

The individual section lengths are obtained by accumulating the lengths of the backsight and foresight of each setup of the respective running, which in turn are usually obtained as a function of the corresponding stadia intercepts (see Stadia under OBSERVATION DATA RECORDS) and the stadia factor of the leveling instrument used. For this purpose, use the minimum section length if more than one running has been made over a section, as is the normal case.

The accumulated distance (as well as the field elevation - see below) is carried on the *30* record to provide a check against certain undetected keying errors, line order errors, errors in the assignment of survey point serial numbers, etc. For this reason, the accumulated distance entered in this field must be the value which is normally computed and "abstracted" in the course of the differential leveling operation. In particular, the accumulated distance must not be generated (e.g., by software) from the respective *41* and *42* records (see OBSERVATION DATA RECORDS), as this would defeat the purpose for which it is intended.

Field Elevation: The approximate elevation of the survey point in question is obtained as the (algebraic) sum of the elevation of the starting point of the leveling line and the raw (i.e., uncorrected) elevation differences determined for the intervening sections (following the line-order conventions used for the ordering of the *30* records in the case of a survey point located on a spur or leveled to via a spur loop - see Order of the *30* Records). (Recall that a "section" is a segment of the leveling line consisting of two neighboring survey points connected by a chain of differential leveling observations referred to as a "running.")

The end product of every running over a section of the leveling line is the respective observed, uncorrected elevation difference (see Elevation Difference under OBSERVATION DATA RECORDS). When more than one running has been made over a section, as is the normal case, a "section mean" must be computed using all forward and backward runnings made over that section which have passed appropriate field rejection criteria.

Noting that a backward running produces an elevation difference of opposite sign, the respective section mean is defined as the algebraic difference between the sum of elevation differences determined by forward runnings and the sum of elevation differences determined by backward runnings divided by the number of runnings. In other words, if ΣF is the sum of all acceptable forward-running elevation differences, and ΣB is the sum of all acceptable backward-running elevation differences, the desired section mean is $(\Sigma F - \Sigma B)/n$, where n is the number of runnings.

The field elevation (as well as the accumulated distance - see above) is carried on the *30* record to provide a check against certain undetected keying errors, line order errors, errors in the assignment of survey point serial numbers, etc. For this reason, the field elevation entered in this field must be the value which is normally computed and "abstracted" in the course of the differential leveling operation. In particular, the field elevation must not be generated (e.g., by software) from the respective *41* and *42* records (see OBSERVATION DATA RECORDS), as this would defeat the purpose for which it is intended.

OBSERVATION DATA RECORDS

40 Survey Equipment Record
41 Running Record
42 River/Valley Crossing Record
43 Correction/Rejection Record

The observation data records, identified by *40*-series data codes, are listed above; the block diagrams illustrating the respective formats are given in the FORMAT DIAGRAMS. The purpose of the *40*-series

records is to provide the means to record the differential leveling observations carried out along a leveling line. Recall that a leveling line is a unit of field work consisting of a number of survey points (bench marks and temporary bench marks) connected by differential leveling observations, and that "section" is a segment of the leveling line consisting of two neighboring survey points which are connected by one or more differential leveling observations.

The differential leveling observations carried out over a section of leveling line are of two basic types - runnings and crossings - see below.

Normally, the (observed) elevation difference between the endpoints of a section is determined as the accumulation of a continuous series of small elevation difference measurements, each obtained as the difference between the respective backsight and foresight readings on a pair of leveling rods positioned vertically over "turning points" at a relatively short sight distance from the leveling instrument. This type of differential leveling observation which consists of a chain of small elevation difference measurements (i.e., leveling instrument "setups") is called a "running."

When carried out in the nominal direction of progress of the leveling line, it is called a "forward" running; when carried out in the opposite direction, it is called a "backward" running. A section which is "double-run" (as is the normal case) will have at least one forward and one backward running (among possibly several runnings in either direction) which meet field acceptance criteria (i.e., the disagreement between the respective observed elevation differences does not exceed the tolerance which is in effect for the order and class of the vertical survey in question).

Submit a *41* record for every running carried out along the leveling line, regardless of its field acceptance or rejection status (rejected runnings may be brought within the respective tolerance after various corrections are applied in the course of subsequent data processing). The *41* records must be submitted in sets consisting of a *40* record followed by one or more *41* records - one for each running made on the same date, using the same leveling instrument and the same leveling rods, and subject to the same level collimation error (see below) as specified in the respective leading *40* record - see STRUCTURE OF THE VERT OBS DATA SET.

The other type of differential leveling observation is the "river/valley crossing" (or "crossing") which is used when a gap larger than the maximum allowable sight length of a setup must be spanned, as when a river (or dry canyon) must be crossed without using a suitable bridge. This type of differential leveling observation is the result of a series of reciprocal measurements carried out simultaneously from both sides of

such a gap using special "valley-crossing" equipment. Note that each individual river/valley crossing must be treated as a separate section of the leveling line.

Submit a *42* record for every river/valley crossing along the leveling line. The *42* records, if any, must appear as the last group of records of the respective leveling line block in the VERT OBS data set (see STRUCTURE OF THE VERT OBS DATA SET).

Submit a *43* record for each running or river/valley crossing for which a refraction correction was determined from temperature profile measurements made by field personnel, or for which a rod correction was determined using detailed rod calibrations furnished by the National Bureau of Standards. Also, if a running or river/valley crossing was rejected, include a *43* record indicating the source of the rejection (field or office). Each required *43* record should immediately follow its corresponding *41* or *42* record. If temperatures were observed only at the upper- and lower- temperature probes, leave the columns labeled "Mean temperature for middle probe" and "Height of middle probe" blank. The columns labeled "Rod Correction in mm" refer to values determined using "detailed" rod calibrations (the calibration of all rod graduations) furnished by the National Bureau of Standards.

Level Collimation Error: The (small) angle by which the line of sight defined by the center of the crosslines in the reticle and the optical center of the objective lens of a leveling instrument departs from the horizontal when the instrument is "level": positive when the line of sight deviates upward, and negative when the line of sight deviates downward from horizontal. The collimation error is due to a small misalignment between the respective bubble vial (in the case of spirit-level instruments) or compensator mechanism (in the case of self-aligning instruments) and the line of sight (line of collimation).

The level collimation error can be resolved into two components--a residual constant component (which can be minimized by careful adjustment of the instrument) and a variable component which is caused by transient deformation of the structural parts of the instrument brought about by stresses and strains due to uneven temperature distribution (differential heating) and other intermittent physical forces which are active in the course of the daily handling of the leveling instrument.

Because of the unpredictable nature of the intermittent component, the level of collimation error must be determined at sufficiently frequent intervals to permit the application of meaningful corrections to the respective leveling rod readings. Note that the effect of the collimation error cancels for a setup with backsight and foresight of equal length; it is the total accumulated length imbalance between all the backsights and foresights of a funning to which the correction for collimation error is applicable.

Tangent of Collimation Error: The observing procedure by means of which the collimation error is determined (commonly known as the "C-Test") produces the ratio of the corresponding rod reading error to the length of line of sight, i.e., the trigonometric function tangent of the collimation error.

Note that the tangent of an angle is a unitless number; however, since it is a very small (positive or negative) decimal fraction, it is convenient to use the tangent of collimation error multiplied by 1000 (i.e., as millimeters per meter, if the metric units are being used). Accordingly, enter the tangent of collimation error with the decimal point moved three places to the right.

Wind Code: A one-character numeric code, the purpose of which is to denote the approximate wind conditions prevailing during the course of the running. The three wind codes are:

0 - wind speed less than 10 kilometers per hour
1 - wind speed from 10 to 25 kilometers per hour
2 - wind speed greater than 25 kilometers per hour

Sun Code: A one-character numeric code, the purpose of which is to denote the approximate conditions of insolation prevailing during the course of the running. The three sun codes are:

0 - less than 25% of setups under sunny conditions
1 - 25% to 75% of setups under sunny conditions
2 - more than 75% of setups under sunny conditions

Stadia, Stadia Intercept, and Stadia Intercept Code: Stadia is a method of obtaining the approximate distance (typically to the nearest 0.1 meter) between the leveling instrument and a vertically positioned leveling rod as the product of the instrument's stadia factor (as specified in the corresponding *20* record) and the respective stadia intercept - the difference between the high and low stadia line readings on the respective rod. Recall that stadia lines are two horizontal lines spaced equally above and below the horizontal crossline in the reticle of the leveling instrument. Note that the distance obtained in this manner is in the same units as the stadia intercept, i.e., in rod units of the respective leveling rod (as specified in the corresponding *21* record).

For differential leveling observations, stadia information is desired (1) to compute the total length of the running, and (2) to compute the total accumulated length imbalance between the backsights and foresights of the running (to eliminate the residual effect of collimation error - see Level Collimation Error above). Because of the latter requirement, two fields are provided for the entry of stadia information, one for the Sum of Backsight Stadia Intercepts and the other for the Sum of Foresight Stadia Intercepts.

As was mentioned previously, the two stadia lines are equidistant from the horizontal crossline (level line) of the leveling instrument. The use of full stadia intercepts requires the observation and recording of two rod readings (the stadia high and the stadia low readings) in

addition to the level line reading. It is possible to observe only one stadia line reading (either the stadia high or the stadia low) in addition to the level line reading, in which case half stadia intercepts are obtained. Note that either full stadia intercepts or half intercepts must be observed consistently throughout a running. To specify which one of the two possible procedures has been followed, provision is made on the *41* record for a one-letter Stadia Intercept Code:

F - full stadia intercepts observed
H - half stadia intercepts observed

Units: A set of two-letter codes for the various units of length in which the length of running (*41* record), length of crossing (*42* record), and elevation difference (*41* and *42* records) may be given. It is the same set of unit codes which is used on the *30* record to denote the units of accumulated distance and field elevation - see FIELD ABSTRACT DATA RECORDS. The specific unit codes are:

MT - meters	KM - kilometers
FT - feet	KF - kilofeet
YD - yards	SM - statute miles

Running Length: The overall length of the running (i.e., the distance covered by the differential leveling observations), preceded by the respective units code, only if the stadia information (see above) is not available; otherwise leave blank.

Crossing Length: Enter the overall length of the crossing (i.e., the distance spanned by the river/valley crossing observations), preceded by the respective units code.

Elevation Difference: Enter the observed difference of elevation as determined by the running or crossing in question, preceded by the respective units code. Note that this must be the raw observed elevation difference, i.e., the result of the running or crossing observations to which no corrections have been applied.

FORMAT DIAGRAMS

For each record which appears in a VERT OBS data set (see Table 6-1), a block diagram has been prepared to illustrate the respective format. These "format diagrams" have been designed to fulfill the following objectives:

1. Each record is 80 characters long (standard punched card image).

2. Each record has a fixed format, i.e., every data field has a specific length and specific position within the record.

3. Each format diagram is a graphic image of the respective record.

4. Within the limits of available space, information and instructions concerning the data item to be entered in each data field are provided on the format diagrams to render them self-explanatory.

5. When appropriate, sample entries are shown in the data entry line of each format diagram.

6. Each data field is characterized as to its type by a string of lower-case characters which appear immediately below the data entry line.

Data Field Types:

1. Alpha Field (aa...a) - intended for a data item which is coded as a string of alphabetic, numeric, and/or special characters, with or without imbedded blanks, to be entered into the respective data field left-justified and blank-filled on the right. See Chapter 5 for a list of special characters which are allowed.

2. Blank Field (bb...b) - to be blank-filled. Data fields which are designated as blank fields must be left blank, i.e., no data items may be entered in these fields.

3. Constant (Numeric) Field (cc...c) - intended for a data item which is a number (i.e., an integer, a proper or improper fraction, or a decimal fraction) coded as a string of numeric characters (prefixed with a minus sign if the number is negative) which may contain one leading or imbedded (but not trailing) decimal point if it is a decimal fraction, or an imbedded hyphen and/or slash if it is a proper or improper (mixed) fraction such as 3/4, 5-1/2, etc., to be entered into the respective data field left-justified and blank-filled on the right.

4. Floating-Point Field (ff...fdd...d) - intended for a data item which is coded as a decimal number, i.e., as a string of numeric characters (prefixed with a minus sign if the number is negative) which may not contain any imbedded blanks. If the decimal point is present, the character string representing the integer digits, the decimal point, and the decimal fraction digits may be positioned anywhere within the respective field (generally left-justified), and the unused columns of the data field are blank-filled.

When the decimal point is not coded, the "f" portion of the floating-point field is to contain the integer part of the decimal number, and the "d" portion the corresponding decimal fraction part,

the decimal point being implied between the rightmost "f" column and the leftmost "d" column of the field.

Accordingly, a string of numeric characters representing m integer digits followed by n decimal fraction digits with the decimal point absent must be positioned in the floating-point field in such a manner that its integer part falls into the m rightmost "f" columns, and its decimal fraction part into the n leftmost "d" columns, with any unused columns of the data field being blank-filled. When a negative number is entered, code the minus sign immediately preceding the leading digit.

5. Integer Field (ii...i) - intended for a data item which is coded as a string of numeric characters representing a positive or negative integer number, to be entered into the respective data field right-justified. In the case of a positive integer number, zero-fill any unused columns on the left. In the case of a negative integer number, code the minus sign immediately preceding the leftmost non-zero digit, and blank-fill any unused columns to the left of the minus sign.

6. Specific Character Field (ss...s) - intended to contain a specific alphabetic, numeric, special character, or a specific group of characters. Every "s" column of a specific character field must contain the character shown in that position in the data line of the respective format diagram.

Required Data: In general, only those records which are applicable to the data at hand should be included in a VERT OBS data set (e.g., no *42* records need be submitted if there are no river/valley crossings along the respective leveling line). The character fields intended for data items which are essential have been shaded on the format diagrams; if applicable to the data being coded, these character fields must be in accordance with the instructions given on the respective format diagrams or in the text of this chapter. Records which are optional or those which may be omitted under certain circumstances are clearly designated in the headings, footnotes, or bodies of the corresponding format diagrams.

Data Set Identification Record. This must be the first record of every data set submitted. A data set may be submitted either as a deck of cards or as a magnetic tape file containing formatted records. Magnetic tape is preferred; use punched cards for small, isolated jobs only.

000000 123456	0001 7890	1111 1234	1111 5678	122222 901234	222223333333333444444444455555555556666666 5678901234567890123456789012345678901234 56	666777 789012	77777778 34567890
Sequence Number - must be 000010 on this record. Increment by 10 on successive records to allow for insertions.	Data Set Identification: Job Code - preceded and followed by asterisk.	Data Set Identification: Data Class - VERT for vertical control data.	Data Set Identification: Data Type - OBS for field observation data.	Name of Submitting Agency or Firm: Abbreviation - must be unique. Enter the symbol listed in ANNEX C. See footnote for other agencies or firms.	Name of Submitting Agency or Firm: Full Name		Date Data Set Created (e.g. date this record keyed) Century, year, month, day (CCYYMMDD). If day is unknown, leave last two columns blank. If month is unknown, leave last four columns blank.
000010	*CX*	VERT	OBS	USGS	US GEOLOGICAL SURVEY		19780510
iiiiii	saas	ssss	ssss	aaaaaa	aaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaa	bbbbbb	iiiiiiii

Important: To insure uniqueness, agencies or firms not listed in ANNEX C must have their proposed abbreviation symbol accepted by NGS prior to first submittal of data - see ANNEX K.

10 Line Information Record. This must be the leading record of each leveling line included in the job - note that a VERT OBS job consists of one or more leveling lines. A code is provided to indicate whether the survey is an original leveling or a releveling of the line - see footnotes.

1 = single or double - simultaneous run
2 = double run

ORDER AND CLASS OF SURVEY								
ORDER	1st			2nd			3rd	LOWER
CLASS	*	I	II	*	I	II	**	**
CODE	10	11	12	20	21	22	30	40

*Class unspecified **No class subdivision

Agency which made the observations. For agencies or firms listed in ANNEX C, enter the respective six-character abbreviation. For others, enter the full or abbreviated name (up to 20 characters) - see ANNEX C for examples.

Initials of Chief of Party - i.e., person responsible for the survey; leave blank if unknown.

State or Country Code - see ANNEX A. Enter the code(s) for the state (or country) in which the leveling line begins (and into which it extends).

Order and Class of Survey - see table above.

Tolerance Factor used to compute maximum disagreement allowed for each double-run section of the line - see footnote. — Factor / Units

Date Field Observations Terminated
Century, year, month, day (CCYYMMDD).
If day is unknown, leave last two columns blank.
If month is unknown, leave last four columns blank.

Date Field Operations Commenced
Century, year, month, day (CCYYMMDD).
If day is unknown, leave last two columns blank.
If month is unknown, leave last four columns blank.

Releveling Code - see footnote.

Agency-specific pointer to its own archives - usually given as an "accession number" (or other cataloguing symbol) which identifies the block of data, possibly supplemented by a further "line" or "part" designation. — Line/Part / Accession Number

Data Code - preceded and followed by asterisk. (*10* - Line Information Record)

Sequence Number
Increment by 10 on successive records to allow for insertions.

nnnnnn*10*L22024 2 R1969111019700608MM3.0 11CA CS NGS 1

Releveling Code: Enter R if releveling over previously established line; leave blank otherwise.

Units (of Tolerance Factor): MM - mm/square-root of km, FT - feet/square-root of statute miles.

11 Line Title Record (Optional) and *12*,*13*,*14* Line Title Continuation Records (Optional).
Use the *11* record to give the title of the line (or of area network or special project of which the line is a part) and the *12*,*13*,*14* records for continuation and/or subtitles, if any.

00000000011111111112222222223333333334444444455555555566666666677777777778 12345678901234567890123456789012345678901234567890123456789012345678901234567890	
Line Title - use *12*,*13*,*14* Line Title Continuation Record(s) as required if the title exceeds 70 characters or if subtitles are necessary (e.g. the title of an area network followed by title of the line). The title of a leveling line should be descriptive of the route followed, i.e., it should indicate the starting and ending locations and prominent "via" points, if any (Example: ALBANY GA VIA MORVEN TO CALLAHAN FL). Do not divide words (or other character groups) between the *11*,*12*,*13*,*14* Line Title and Line Title Continuation Records. Omit punctuation marks (periods, commas, etc.) and parentheses whenever possible. Use ANNEX A state and country codes whenever reference to a state or country is necessary. Abbreviate and/or edit a line title in the interest of fitting the entire title on the *11* Line Title Record, if possible.	nnnnnn*11*TULARE-VASCO ARVIN-MARICOPA AREA CA nnnnnn*12*9.1 KM SE OF KETTLEMAN CITY TO PIXLEY
Data Code (*11*,*12*,*13*,*14* Line Title Records)	111111sssaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaa
Sequence Number Increment by 10 on successive records to allow for insertions.	00000000011111111112222222223333333334444444455555555566666666677777777778 12345678901234567890123456789012345678901234567890123456789012345678901234567890

15 Comment Record (Optional). Use this record for any comments pertinent to the leveling line. If the comment(s) exceed 70 characters, use another *15* record for continuation; any number of *15* records is allowed. Do not divide words between consecutive *15* records.

00000000011111111112222222222333333333344444444445555555555666666666677777777778		
12345678901234567890123456789012345678901234567890123456789012345678901234567890		
Sequence Number Increment by 10 on successive records to allow for insertions.	Data Code (*15* - Comment Record)	Comment
nnnnnnn	*15*	GRAVITY SURVEY OBSERVED OVER THIS LINE.
iiiiiii	siis	aaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaa
00000000011111111112222222222333333333344444444445555555555666666666677777777778		
12345678901234567890123456789012345678901234567890123456789012345678901234567890		

20 Instrument Information Record. Submit this record for every instrument (identified by the respective Survey Equipment Code and Instrument Serial Number) once for each past stadia factor determination (to form historical file) and when a new stadia factor is determined - see footnote.

00000000011111111222222223333333334444444455555555566666666677777777778 12345678901234567890123456789012345678901234567890123456789012345678901234567890		
Stadia Factor - instrument-specific number which multiplied by Stadia Intercept gives dist to rod.		100
Date Determined - year, month, day (YYMMDD). If day is unknown, leave last two columns blank. If month is unknown, leave last four columns blank.		750217
Agency which owns or has the custody of the instrument. For agencies or firms listed in ANNEX C, enter the respective six-character abbreviation. For others, enter the full or abbreviated name (up to 20 characters) - see ANNEX C for examples.		NGS
Model or Type - examples: FISHER N-3 NK3-M NI1 NI-002		NI1
Manufacturer - examples: USC+GS WILD KERN ZEISS/OBERKOCHEN ZEISS/JENA K+E HILGER-WATTS		ZEISS/OBERKOCHEN
Instrument Serial Number - alphanumeric, left-justified.		90760
NGS Survey Equipment Code - see ANNEX F.		231
Data Code (*20* - Instrument Information Record)		*20*
Sequence Number Increment by 10 on successive records to allow for insertions.		nnnnn

Note: Omit for those instruments for which *20* record(s) containing identical information have been given in another line of this data set - or in a previously submitted VERT OBS data set.

21 Rod Information Record. Submit this record for every rod (identified by the respective Survey Equipment Code and Rod Serial Number) once initially with or without one or more *22* (Rod Standardization) and/or *23* (Rod Calibration) Records for that rod - see footnote.

00000000011111111222222223333333334444444455555555566666666677777778 12345678901234567890123456789012345678901234567890123456789012345678		
1-line graduation (single scale) 2-line graduation (double scale) 3-block graduation (including checkerboard) 4-other Graduation Code - see above.		HC22
Rod Units - CF,CM,CY, or HC - see below.		
Rod Units: CF-centifoot (0.01ft) CM-centimeter (0.01m) CY-centiyard (0.01yd) HC-half centimeter (0.005m) Agency which owns or has the custody of the rod. For agencies or firms listed in ANNEX C, enter the respective six-character abbreviation. For others, enter the full or abbreviated name (up to 20 characters) - see ANNEX C for examples.		NGS
Model or Type - examples: INVAR NILEX LOVAR WOOD		INVAR
Manufacturer - examples: USC+GS WILD KERN ZEISS/OBERKOCHEN ZEISS/JENA K+E HILGER-WATTS		KERN
Rod Serial Number - alphanumeric, left-justified.		
NGS Survey Equipment Code - see ANNEX F.		
Data Code (*21* - Rod Information Record)		nnnnnn*21*316120900
Sequence Number Increment by 10 on successive records to allow for insertions.		

Note: Aside from being required at least once initially for every rod, this record must precede every *22* and/or *23*,...,*22* and/or *23* record group subsequently submitted for any given rod.

22 Rod Standardization Record. Submit this record for every rod (with or without accompanying *23* record(s)) once for each past standardization or calibration (to form historical file) and whenever restandardized or recalibrated (NOT REQUIRED FOR 3RD AND LOWER ORDER) - see footnote.

UNITS OF COEFFICIENT OF EXPANSION		
ROD UNITS	TEMPERATURE SCALE	
	C	F
CF	feet/degree C	feet/degree F
CM	meters/degree C	meters/degree F
CY	feet/degree C	feet/degree F
HC	meters/degree C	meters/degree F

0000000001111111112222222223333333334444444445555555556666666667777777778
1234567890123456789012345678901234567890123456789012345678901234567890
NOTE - The *22* record is optional if all data elements hereunder are inferable from accompanying *23* records.
Optional if inferable from accompanying *23* record(s).
Index Error in rod units - see text.
Rod Excess x1000 (i.e., enter with decimal point moved three places to the right) - see text.
A-Flag - A-assumed, blank otherwise. Coefficient of Expansion x10000 (i.e., enter with decimal point moved four places to the right) - see text.
Standardization Temperature
Scale - C-Celsius, F-Fahrenheit.
Date of Standardization - year, month, day (YYMMDD). If day is unknown, leave last two columns blank. If month is unknown, leave last four columns blank.
Laboratory or other source of standardization - see ANNEX C. Enter MAKER if furnished by the manufacturer.
Rod Serial Number - alphanumeric, left-justified.
NGS Survey Equipment Code - see ANNEX F.
Data Code (*22* - Rod Standardization Record)
Sequence Number Increment by 10 on successive records to allow for insertions.

0000000001111111112222222223333333334444444445555555556666666667777777778
1234567890123456789012345678901234567890123456789012345678901234567890
rnnnn*22*316120900 NBS 750211C25.0.0080 A-.0650 -.01534
iiiiiisiiiaaaaaaaaaaaaaaaaiiiiiiacccccccccccccccccbbbbbbbbbbbbbbbbbbbb
0000000001111111112222222223333333334444444445555555556666666667777777778
1234567890123456789012345678901234567890123456789012345678901234567890

Note: Omit for those rods for which *22* and/or *23* record(s) containing identical data have been given in another line of this data set, - or in a previously submitted VERT OBS data set.

23 Rod Calibration Record. In addition to the respective *22* record, submit one or more *23* records for every past single- and multiple-temperature calibration of the rod for which the data are available and when recalibrated (NOT REQUIRED FOR 3RD AND LOWER ORDER) - see footnote.

0000000001111111112222222223333333334444444445555555556666666667777777778
1234567890123456789012345678901234567890123456789012345678901234567890
For each interval, specify the point on the rod (XXX in rod units) at which the calibration measurement starts, the point at which it ends, and the measured length of the respective interval (Xxxxxxx in feet, meters, or yards - as per Units of Measured Length).
INTERVAL 1 / INTERVAL 2 / INTERVAL 3
Starting Point in rod units. / Ending Point in rod units. / Measured Length - in feet, meters, or yards (see Units of Measured Length); decimal point implied after column 47.
Starting Point in rod units. / Ending Point in rod units. / Measured Length - in feet, meters, or yards (see Units of Measured Length); decimal point implied after column 60.
Starting Point in rod units. / Ending Point in rod units. / Measured Length - in feet, meters, or yards (see Units of Measured Length); decimal point implied after column 73.
Calibration Temperature
Units of Measured Length (FT, MT, or YD). .
Scale - C-Celsius, F-Fahrenheit.
Date of Calibration - year, month, day (YYMMDD). If day is unknown, leave last two columns blank. If month is unknown, leave last four columns blank.
Laboratory or other source of calibration - see ANNEX C. Enter MAKER if furnished by the manufacturer.
Rod Serial Number - alphanumeric, left-justified.
NGS Survey Equipment Code - see ANNEX F.
Data Code (*23* - Rod Calibration Record)
Sequence Number Increment by 10 on successive records to allow for insertions.

nnnnnn	*23*	316	120900	NBS		750211	C	25.0	MT	000	200	1000	050	0004	00	2000	070	0006	00	3000	090				
iiiiii	siis	iii	aaaaaaaaa	aaaaaaa		iiiiii	a	cccc	aa	iii	iii	fddddd	d	iii	iii	fddddd	d	iii	iii	fddddd	d	b			
000000	0001	111	11111122	222222		223333	3	33334		444	444	444555	5	555	555	666666	6	666	777	777777	8				
123456	7890	123	45678901	234567		890123	4	56789	0	123	456	789012	3	456	789	012345	6	789	012	345678	9	0			

Note: Omit for those rods for which *22* and/or *23* record(s) containing identical data have been given in another line of this data set - or in a previously submitted VERT OBS data set.

30 Field Abstract Record. Submit this record for the first (starting) survey point (bench mark or temporary bench mark) and thereafter for each elevation carried forward (possibly more than once for any given survey point) in the order of occurrence along the leveling line - see text.

000000 123456	0001 7890	1111 1234	1111122222222223333333333 5678901234567890123456789	44 01	44444444 23456789	55 01	5555555566 2345678901	666666667777777778 234567890123456789 0
				Important: Data items hereunder must be keyed from the Field Abstract and not generated from the respective *41*/*42* records - see text.				
				Accumulated Distance		Field Elevation		
Sequence Number Increment by 10 on successive records to allow for insertions.	Data Code (*30* - Field Abstract Record)	Survey Point Serial Number (SPSN) - see Chapter 5. Must be same as SPSN used in VERT DESC data set.	Designation - must not exceed 25 characters. This is the primary designation which will be associated with the vertical control point for publication purposes. In every case, the designation must be edited in conformity with Guidelines for Survey Point Names and Designations (ANNEX D). The designation entered in this field must be identical (character for character) with the designation given for the same point in the corresponding VERT DESC data set.	Units - see footnote.	Accumulated Distance - see text. Enter left-justified and key the decimal point.	Units - MT, FT, or YD.	Field Elevation - see text. Enter left-justified and key the decimal point. Prefix minus sign if applicable.	
nnnnnn	*30*	0187	D 1056	KM	23.49	MT	57.11702	
iiiiii	siis	iiii	aaaaaaaaaaaaaaaaaaaaaaaaa	aa	cccccccc	aa	cccccccccc	bbbbbbbbbbbbbbbbbbb
000000 123456	0001 7890	1111 1234	1111122222222223333333333 5678901234567890123456789	44 01	44444444 23456789	55 01	5555555566 2345678901	6666666677777777778 2345678901234567890

Units: MT - meters, KM - kilometers, FT - feet, KF - kilofeet, YD - yards, SM - statute miles

40 Survey Equipment Record. Submit this record at the start of every day's work and whenever an item of survey equipment changes, height of instrument changes by 5 cm or more, the heights of the temperature probes change, or the collimation error is redetermined, to be followed by one or more *41* records for the runnings to which data on the *40* record are applicable.

NOTE - Collimation error data are not required for 3rd- and lower-order differential leveling.		
Time of Collimation Error Determination	Local Time - hours and minutes (HHMM).	
	Time Zone - see ANNEX H.	
Tangent of Collimation Error x1000 (i.e., enter with decimal point moved three places to the right) - see text. Leave blank if none determined.		
Height of middle temperature probe in centimeters.		
Height of lower temperature probe in centimeters.		
Height of upper temperature probe in centimeters.		
Average height of instrument in centimeters.		
ROD 2	Rod Serial Number - alphanumeric, left-justified. Must be identical to the serial number given on the corresponding *21* record	
	NGS Survey Equipment Code - see ANNEX F.	
ROD 1	Rod Serial Number - alphanumeric, left-justified. Must be identical to the serial number given on the corresponding *21* record	
	NGS Survey Equipment Code - see ANNEX F.	
INSTRUMENT	M-Flag - M if micrometer used, blank otherwise	
	Instrument Serial Number - alphanumeric, left justified. Must be identical to the serial number given on the corresponding *20* record	
	NGS Survey Equipment Code - see ANNEX F.	
Date of Running(s) - year, month, day (YYMMDD). If day is unknown, leave last two columns blank. If month is unknown, leave last four columns blank.		
Data Code (*40* - Survey Equipment Record)		
Sequence Number Increment by 10 on successive records to allow for insertions.		

Important: This must be the leading record of every *40*,*41*,*41*,*41*,....,*41* set containing runnings made on the same date using the same equipment and affected by the same collimation error.

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41 Running Record. Submit this record for every running other than river/valley crossing. The *41* records for all runnings made on the same date, using the same equipment, to which the same collimation error applies must follow, as a group, immediately behind the respective *40* record.

Initials of the Observer - left-justified.	
Elevation Difference - observed, uncorrected elevation difference determined by the running.	Elevation Difference - in the units indicated, left-justified. Units - MT, FT, or YD.
Length of Running - if stadia data unavailable; leave blank otherwise.	Length of Running - in the units indicated, left-justified. Units - see *30* record
Stadia - enter to the nearest 0.1 of the respective rod unit. Note implied decimal point.	Sum of Foresight Stadia Intercepts Sum of Backsight Stadia Intercepts
Stadia Intercept Code - F-full, H-half.	
Number of Setups in the running.	
Wind and Sun Codes - see footnotes.	
Temperature of Air	Temperature at ending time and place - left-justified. Temperature at starting time and place - left-justified. Scale - C-Celsius, F-Fahrenheit.
Local Time in hours and minutes (HHMM).	Ending Time of running. Starting Time of running. Time Zone - see ANNEX H.
Ending Survey Point Serial Number (SPSN) - must be same as SPSN on the corresponding *30* record.	
Starting Survey Point Serial Number (SPSN) - must be same as SPSN on the corresponding *30* record.	
Date of Running - year, month, day (YYMMDD). If day is unknown, leave last two columns blank. If month is unknown, leave last four columns blank.	
Data Code (*41* - Running Record)	
Sequence Number Increment by 10 on successive records to allow for insertions.	

Wind Code: 0 - less than 10 km/hour, 1 - 10-25 km/hour, 2 - more than 25 km/hour wind speed.

Sun Code: 0 - less than 25%, 1 - 25-75%, 2 - more than 75% of setups under sunny conditions.

42 River/Valley Crossing Record. Submit this record for each river/valley crossing along the leveling line.

Elevation Difference - observed, uncorrected elevation difference determined by the crossing.	Elevation Difference - in the units indicated, left-justified.		
	Units - MT, FT, or YD.		
Total Length of the river/valley crossing.	Length of Crossing - in the units indicated, left-justified.		
	Units - see *30* record.		
Local Time in hours and minutes (HHMM).	Ending Time of crossing.		
	Starting Time of crossing.		
	Time Zone - see ANNEX H.		
Ending Survey Point Serial Number (SPSN) - must be same as SPSN on the corresponding *30* record.			
Starting Survey Point Serial Number (SPSN) - must be same as SPSN on the corresponding *30* record.			
Date of Crossing - year, month, day (YYMMDD). If day is unknown, leave last two columns blank. If month is unknown, leave last four columns blank.			
Data Code (*42* - River/Valley Crossing Record)		*42*	
Sequence Number Increment by 10 on successive records to allow for insertions.			

43 Correction/Rejection Record. Submit this record for each running or river/valley crossing when 1) temperature profiles were measured in the field, 2) a rod correction can be determined using detailed rod calibrations furnished by the National Bureau of Standards, or 3) the running or river/valley crossing is to be rejected.

Columns	Field description	Example	Type
1–6	Sequence Number. Increment by 10 on successive records to allow for insertions.	nnnnnn	iiiiii
7–10	Data Code - preceded and followed by asterisk (*43* - Correction/Rejection Record)	*43*	siis
11–16	Date of Running or River/Valley Crossing - year, month, day (YYMMDD)	790914	iiiiii
17–20	Starting Survey Point Serial Number (SPSN)	0122	iiii
21–24	Ending Survey Point Serial Number (SPSN)	0123	iiii
25–28	Starting Time of Running or River/Valley Crossing	1452	iiii
29–35	Refraction Correction in mm. Enter left-justified and key the decimal point.	-1.21	ccccccc
36	Field/Office Rejection - see note above.		a
37–43	Rod Correction in mm. Enter left-justified and key the decimal point.	-0.81	ccccccc
44	Temperature Scale C - Celsius F - Fahrenheit	C	a
45–49	Mean temperature for upper probe. Enter left-justified and key the decimal point.	19.1	ccccc
50–54	Mean temperature for lower probe. Enter left-justified and key the decimal point.	20.1	ccccc
55–59	Mean temperature for middle probe. Enter left-justified and key the decimal point.	19.4	ccccc
60	Temperature Code. O-Observed, P-Predicted.	P	a
61–80	Note - Field/Office Rejection Codes: F = Field rejection O = Office rejection ƀ = not rejected		bbbbbbbbbbbbbbbbbbbb

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Data Set Termination Record. This must be the last record of every data set submitted.

Data Set Structure: A VERT OBS Data Set consists of one or more leveling lines.

Data Set Identification Record	
10-series records *20*-series records (if any) *30* records *40*-series records	FIRST LINE
10-series records *20*-series records (if any) *30* records *40*-series records	SECOND LINE
:::: ::::	:::: ::::
10-series records *20*-series records (if any) *30* records *40*-series records	LAST LINE
Data Set Termination Record	

Job Code - preceded and followed by asterisk.

Sequence Number
Increment by 10 on successive records to allow for insertions.